International political economy and renewable energy: hydroelectric power and the potential for a resource curse

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International Political Economy and Renewable Energy: Hydroelectric Power and the Resource Curse

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Abstract: One of the most studied issues regarding the role of natural resources in development is the so-called "resource curse," the paradoxical (and contested) situation in which a state with abundant resources has low rates of economic growth per capita, high levels of income inequality, low levels of democracy, high gender inequality, and high levels of domestic and international conflicts that surround resources. Although the term implies all resources, most research by political scientists as well as economists and other social scientists examines the role of oil and hard minerals, leaving out many resources, including renewable energy resources. We argue that many of the causal mechanisms behind the curse, when it does manifest, hold for water-abundant states who have sufficient resources to create large hydroelectric projects. Drawing on illustrative examples of hydroelectric projects around the world, we demonstrate sufficient, albeit preliminary, evidence that most aspects of the resource curse literature apply to hydroelectric projects, at least in some states, and thus suggest the curse literature should be expanded to include water-abundance. In addition, we add a new factor, variable fuel supply, which could be an important factor for other resources as well. We conclude with suggestions for developing a research agenda and note a number of policy implications.

Keywords: resource curse, hydroelectricity, energy

Introduction

We argue that a state's abundance of fast-flowing rivers harnessed to generate electricity could turn out to be as much a curse as a blessing. Over the last few decades, scholars have developed a significant and sophisticated literature around the so-called resource curse, the paradoxical (and contested) situation in which a state with abundant natural resources fares poorly in terms of economic growth, income equality, political governance, and gender equality. Despite the term, most research examines the role of only petroleum (by definition, crude oil and natural gas) rather than the larger group of natural resources. Of those focused on energy resources, few investigate coal and uranium, or the variety of renewable resources such as sun, wind, biomass, and water. Studies that do look at these other resources tend to reach indefinite conclusions. In one of the few assessments of renewable energy resources, Eisgrubler analyzes the extent to which hydropower in Laos, wind energy in Mongolia, and solar energy in the Middle East and North Africa could contribute to the resource curse (Eisgruber 2013). He finds that exports of electricity from these renewable sources escaped some aspects of the curse, such as economic shocks after resource depletion and competition over fixed amounts of resources, but exhibited other aspects of the curse such as a crowding out of exports, higher corruption, and lower government accountability. Månsson examines the link between renewable energy systems and social conflict but does not disaggregate his analysis to focus on particular technologies such as wind energy or hydroelectricity (Månsson 2015).

Focusing on one renewable resource, we offer a qualitative, exploratory study that illustrates the ways that water used for hydroelectricity might create a type of resource curse or blessing. To make this case, we first provide background on the global hydroelectricity sector. Hydroelectric power is the biggest renewable electricity source used worldwide, yet has received little attention from political scientists. We then investigate the logic of the resource curse as developed in the extant literature, breaking down the various components (economic, political, social, and security) and types of resources, and then applying this logic to states with poorly developed political institutions and powerful rivers that can be dammed to generate electricity. We note that political leaders in developing states can gain significant rents from hydroelectric projects used by wealthy states and multinational corporations for mining and other industries with relatively low employment needs, leading to host state citizens receiving little if any gains in terms of higher living standards (improved health and education and greater access to electricity, for example). Hydroelectric power can also lead to higher environmental and social costs (e.g., from disease-ridden standing water, warmer water that harms fish populations, and citizen relocation), worsened or unimproved indicators of democracy (freedom of speech, free and fair elections, etc.) and less security due to resource-related conflicts. Using previous research on a variety of hydroelectric projects, we offer supporting evidence for each of these claims. We then conclude with recommendations on how scholars can fruitfully use the resource curse literature to assess the value of hydroelectric dams, and how dams suggest other avenues of research for scholars who engage the resource curse literature.

The Hydroelectricity Industry

The hydroelectricity industry plays a key role in current and future electricity production in both the developing and developed worlds. A large-scale hydroelectric dam includes the actual dam to create a reservoir of water, a water intake area, a turbine (which turns with the force of water) and a canal called a penstock that directs the water to the turbine. The turbine turns a generator, creating electricity. Large dams have multiple turbine-generator units: for example, the Hoover Dam in the United States has 17 units and China’s Three Gorges has 26 units (China Three Gorges Corporation 2010, U.S. Bureau of Reclamation 2016). The electricity flows to a powerhouse and is then transmitted through power lines and into industrial sites, businesses, and homes. Withdrawn water is carried through pipes called tailraces and then re-enters the river downstream. Alternatively, water can be collected in a lower reservoir and pumped upstream, using a reverse turbine, to the upper reservoir and used again. When the water is behind the gates, it is stored energy; it becomes kinetic energy when the gates open and the water moves through the penstock. The amount of electricity generated varies depending on the water flow, the hydraulic head, and the distance between the water surface and the turbines, among other factors.

Using proven designs with centuries of experience, hydroelectric dams account for 72.8% of global electricity production from renewable resources; the next most significant renewable resource is wind energy at a distant 13.6%. Overall, hydropower accounts for more electricity generation (16.6%) than nuclear power plants (10.6%) (REN21 2015, fn 10; fn 37). More than 150 countries generate some grid-connected hydroelectricity. Hydroelectric dams supply at least 50% of electricity in more than 60 countries and greater than 90% in about 20 countries. In states as diverse as Bhutan, Norway, Paraguay, and several African countries, essentially all commercial electricity comes from hydroelectricity. As of 2016, there are 9,595 hydropower dams, of which 5,727 are exclusively for electricity production; the rest have multiple uses such as irrigation and flood control (International Commission on Large Dams 2016). Despite the wide use of hydroelectricity, there remains significant untapped energy: using conservative estimates, the World Energy Council states that only about one-third of the world hydropower capacity has been developed (World Energy Council 2016). Tables 1 and 2 provide a global perspective of hydroelectric dams.

Table 1: Largest Hydroelectric Dams and Plants in Operation

No.	Dam	Country	Year of Completion	Installed Capacity (MW)	Energy (TWh/year)
1	Three Gorges (Sanxia)	China	2010	22,500	85
2	Itaipú	Brazil/Paraguay	1991	14,000	90
3	Guri (Simón Bolívar)	Venezuela	1986	10,200	52
4	Tucuruí	Brazil	1984	8,370	21
5	Grand Coulee	USA	1942/1980	6,809	21
6	Sayano-Shushenskaya	Russia	1985/1990	6,400	23
7	Krasnoyarskaya	Russia	1967	6,000	20
8	Robert-Bourassa	Canada	1979	5,616	37
9	Bratsk	Russia	1967	4,500	23

Table 2: Hydroelectric Installed Capacity Based on National Production

Rank	Country	TWh	Percent of World Total

1	China	360	14.0
2	Canada	356	11.3
3	Brazil	349	11.2
4	United States	318	10.2
5	Russia	175	5.6
6	Norway	120	3.8
7	India	114	3.6
8	Japan	96	3.1
9	Venezuela	79	2.5
10	Sweden	62	2.0
	Rest of the world	1016	32.7
	Total	3121	100.0

Sources for Tables 1 and 2: (International Commission on Large Dams 2016, U.S. Department of the Interior 2016)

Note: MW = megawatts; TWh = terawatt-hour, which equals 1 terawatt of energy for an hour

The allure of hydropower rests on several factors. Unlike some renewable energy options, hydropower is a mature technology that is widely considered cost-competitive; operating and maintenance costs are low. (International Energy Agency 2012). It is durable, reliable, and efficient. Hydropower plants can “store” large amounts of energy in reservoirs. Hydropower has considerable potential in parts of the world where demand for energy is expected to grow most significantly: the developing parts of Africa, Asia, and South America. Dams provide other benefits, such as regulating water flows, mitigating floods, and irrigating crops.

Hydropower is seen as playing an especially important role in lower income countries. The International Energy Agency estimates that emerging economies could foster social and economic development by doubling hydroelectric production by 2050. Compared to fossil fuels, increasing energy through hydropower would prevent up to 3 billion tons of carbon dioxide emissions annually (International Energy Agency 2016). Similarly, the Intergovernmental Panel on Climate Change praised hydropower as a catalyst for development, and World Bank reports indicate that large hydropower projects can bring salient multiplier effects of \$0.40 to \$1 for every \$1 invested beyond the cost of the dam (Kumar et al. 2011).

Given hydropower's current and future major role in electricity production and renewed support from development banks and some environmentalists and climate scientists, we explore how water might be prone to its own type of resource curse. To make this case, we connect hydroelectricity with the complex literature on the resource curse, noting the literature's diverse findings in terms of resources being a blessing or a curse. To begin, we provide an overview of the resource curse literature including those aspects that are contested.

Conceptualizing and Contesting the Resource Curse

Starting with Auty, who first named the concept, economists and political scientists have published extensively on the resource curse (Auty 1993). Observations of the alleged curse go back to the 17th century. At this time, the Netherlands was wealthier than Spain, despite gold and silver flowing into Spain, and Switzerland and Japan rushed ahead of mineral rich Russia (Sachs and Warner 1995); these comparisons suggested there was something about resources that paradoxically undermined economic growth. These arguments were given modern force by Argentine economist Prebisch who observed economies of commodity-exporting states in Latin America devastated by collapsing world prices during the late 1920s and the 1930s. (Davis 1995, Hunt 1989). Since these original economic studies that focused on economic growth, scholars have identified a wide variety of ills associated with resource abundance: high income inequality, uneven regional economic development, authoritarian governments, gender inequality, and domestic and international violence.

Despite this evidence, some doubt there is such a curse (Gochberg and Menaldo 2016; Gilberthorpe and Papyrakis 2015), or have found that not all aspects of the multi-dimensional curse hold up when more cases are analyzed or other variables held constant (Ross 2012). Despite its massive diamond wealth, Botswana is often touted as an example of a resource-rich developing state that dodged (some of) the curse: it has been a peaceful state, with relatively high gross domestic product (GDP) per capita (Dunning 2005). Others find that resources can help states consolidate their democracies (Gurses 2011, Liou and Musgrave 2013). In addition, as Tompson argues about Russia, some resource-rich states have many of the problems associated with the curse, but these are not caused by the resources (Tompson 2006).

Overall, there is a growing consensus that resources are not destiny: certain state policies and historical paths can result in wealth, equality, democracy, and peace. Government institutions, including types of contracts, are key factors in whether resource-rich states are cursed or blessed. When political institutions are more "grabber friendly," having more natural resources depresses aggregate income, whereas "producer friendly" institutions increase income (Mehlum, Moene, and Torvik 2006). Using the former Soviet states as their cases, Jones Luong and Weinthal argue that the structure of the natural resource ownership and management (whether state-owned, privately-owned or a mixture) determines whether or not a country suffers from the resource curse (Jones Luong and Weinthal 2010). Others find that states without effective government institutions and increasing dependence on resources tend to deteriorate further over time whereas those with strong democratic institutions in place before their major mineral discoveries, avoid the curse; notable examples of the latter include Australia, Canada, and the Scandinavian countries (De Rosa and Iootty 2012, Alexeev and Conrad 2009).

One of the challenges in assessing the literature is that scholars have not reached a consensus on what defines resource-rich. Auty defines mineral economies as developing states with at least 8% of their GDP and 40% of export earnings from minerals (Auty 1993, 3). Colgan, who focuses on security issues, puts the minimum at 10% of GDP and includes states with modest exports or even net imports, thus increasing the number of states considered resource-rich (Colgan 2014). Haglund sets the bar at 25% or more for the value of exports (Haglund 2011), while Le Billon differentiates between dependence, abundance, and mode of exploitation (Le Billon 2008). In addition, some scholars look at natural resource wealth per capita. Using this measurement, studies have found positive relationships between resource wealth and growth (Brunnschweiler and Bulte 2009) and oil wealth and democracy (Gurses 2011). We do not take a position on the right measurement, but instead point out that how one measures resource-rich affects the findings, including what aspect of the curse might or might not apply. For example, if we lower the threshold for exports, as

Colgan does, the argument about foreign currencies swamping the local currency do not apply, whereas other aspects of the resource curse might still hold. We take this into account in our arguments about hydropower.

A final issue in the literature, and the one we address most directly, is the type of resource that has been at the center of debates. The bulk of the literature, particularly by political scientists, is about oil. Some scholars use the term petroleum, which technically includes natural gas and oil, even when their research is only on oil. This might seem a minor distinction, one that can be glossed over, but the difference is significant and can affect the extent to which the resource curse arguments apply. For example, states that rely on oil exports are more exposed to price fluctuations due to the relatively global market, compared to natural gas exporters and their regional markets.[1] Much of the earlier work and many of the large-*n* studies by economists look at hard minerals as well as oil and gas (Auty 1993). Some studies include the type of natural resources Adam Smith had in mind, such as crop land and timber. A few consider whether coal-rich regions within a state, such as in low-income Appalachia in the United States, are part of the resource curse (Partridge, Betz, and Lobao 2012; Collins, Hansen, and Hendryx 2012). Some studies isolate diamonds, using Sierra Leone as an example of a cursed country or Botswana and Namibia as states that have escaped the curse (Le Billon 2008, Khoury 1990). Additionally, a few scholars have considered whether renewable energy sources create conditions for a curse. Eisgruber shows the export of electricity derived from renewable resources is susceptible to a number of symptoms of the resource curse, including economic issues like crowding out the manufacturing sector and institutional issues like corruption and declining governmental accountability (Eisgruber 2013).

Different resources may trigger different aspects of the curse. For example, coal is most often consumed domestically rather than being a major export and therefore may not create the same kinds of rents as oil or gas. Coal also has fewer price swings than petroleum products (World Coal Association 2017), removing that causal mechanism from the curse argument. Renewable energy sources may not create the same gender inequalities within the sector that we see in the extractive industries (Pearl-Martinez

[1] The distinction between oil as a global market and natural gas as regional is diminishing somewhat as liquefied natural gas is creating a more globalized market.

and Stephens 2016). These are empirical questions; we raise them here to emphasize the importance of analyzing individual aspects of the curse for each type of resource, rather than collapsing all resources, and all causal mechanisms, into a single argument.

In the next section, we dive into the primary focus of the paper: how water via hydroelectric dams can create some of the same problems associate with oil, gas, and hard minerals. We consider the different forms of the potential curse–economic, social, political, and security–and their underlying causal mechanisms.

The Case for a Contingent Water Resource Curse

Much of the logic of the resource curse applies to an abundance of water that can be used for hydroelectric power when it comprises a substantial part of the state's (or provinces') economy and some export earnings. Like petroleum and hard minerals, states are unevenly endowed with water. Furthermore, states choose whether or not to extract or dam these resources for domestic commercial development, local community development, and/or export. As with fossil fuels, low income states often must rely on external actors to fund the projects. These actors usually include multinational corporations based in wealthy states, and sometimes development agencies, including the World Bank and regional development banks. In short, water has much in common with the resources commonly associated with the resource curse.

Below, we discuss myriad causal mechanisms as they might apply to the hydroelectricity industry. We reference specific cases of hydroelectric projects to illustrate how these mechanisms have played out around the world. We refer to a contingent curse, as our conclusions are consistent with the larger literature in finding that water is not destiny: it can create positive or negative outcomes contingent on how political leaders handle the resource.

Economic Growth

The literature identifies four ways that resources can paradoxically undermine the state's economic growth that also apply to hydroelectric power: price fluctuations, Dutch disease, enclave economies, and rent-seeking. In addition, we suggest another causal mechanism that has not previously been included in the curse literature:

variable fuel supply.

Compared to manufactured goods, many commodities are characterized by massive price fluctuations in a short period of time due to external factors, leaving the state more vulnerable. For example, financial speculation in commodity derivatives products, known as the financialization of commodities markets, is believed to cause price increases in food commodities (Clapp 2012, Clapp and Helleiner 2012a, Clapp and Helleiner 2012b). This volatility leads to unstable and unpredictable income for the state, which may lead to overspending, followed by severe economic hardship or even debt default.

Electricity profits share this volatility problem if there is an electricity grid cutting across state borders, making the state vulnerable to other states' actions, such as building new power plants that increase domestic supply and decrease cross-border demand, or foreign policy crises such as a terrorist attack on a power plant that results in sudden increases in demand, or even economic shocks like trade disputes or embargoes. Thus, it is possible for significant price fluctuations, and thus export earnings, to occur with an abundance of hydroelectric power. Whether states have experienced enough of a fluctuation to damage long-term economic growth is a matter for empirical investigation, which we do not pursue here but argue should be part of a research agenda.

Another major factor thought to account for lower growth rate is the Dutch disease, a malady dubbed by *The Economist* in 1977, referring to the appreciation of the Dutch exchange rate following the Netherlands' major natural gas find in the 1960s. Dutch disease results when there is a booming tradable sector following a major discovery of a natural resource. The boom results in the local currency gaining strength, which in turn undermines lagging sectors by raising the costs of their exports, leading to a downturn in trade. The lagging sector is usually manufactured goods and/or agriculture. Furthermore, the higher value of the currency leads consumers to choose to import goods rather than purchasing domestically-manufactured and locally grown agricultural goods, which are comparatively more expensive. The increasing employment demand in the booming sector results in an influx of labor from the lagging and any non-tradable (service) sectors, further undermining the non-boom sectors (Corden 1984). Eventually, the state's economy becomes highly reliant on the boom sector, further exposing it to the fluctuating prices and external shocks. The sudden influx of American gold into the Spanish markets in the 16th century and the negative impact this had on Spanish industries has been interpreted as a pre-petroleum example of Dutch disease (Forsyth and Nicholas 1983). While the Dutch disease can be caused by any booming sector, natural resources are considered likely causes because of their high-export value and discoveries that can lead to a sudden boom.

Although hydroelectricity does not appear to have caused Dutch disease in most hydroelectric states, primarily because most states do not export high enough amounts to create the reaction described above, this has been the case in Laos. A predominately hydropower state, Laos has electricity grid connections to China's Yunnan Province, Thailand, and Vietnam. Most exports go to Thailand and, to a lesser extent, Vietnam. With 20 hydropower projects now completed with a total capacity of 3,000 MW and an expected 40-50 more projects by 2025, the Lao government envisions its state as the "power battery" of the Greater Mekong Subregion (International Finance Corporation 2017a). In 2008, electricity exports equaled $98 million, accounting for 30% of total export revenue. By 2010, export earnings from electricity had jumped to $370 million, following three hydropower plants coming on-line: Nam Theun 2, Nam Ngum 2 and Nam Lik 1/2. More export-oriented hydropower projects are being developed with the help of the Asian Development Bank and numerous foreign companies (Asian Development Bank 2010, 5, 7). The Dutch disease spending effect has led to inflation and real exchange rate appreciation resulting in loss of competitiveness, slowdown in industrialization, and even a shrinking of manufacturing and other tradable sectors (Jusi 2011, 261). Whether this effect has a long-term negative outcome remains to be seen. At this point, some might argue that this very poor, landlocked country has at least found a valuable resource it can export for money it would not otherwise earn.

Enclave economies are also said to account for lower economic growth than expected for a resource-rich state. We find this casual mechanism holds for water as well. Enclaves have few local linkages to the domestic economy, such as factories to supply inputs or process outputs, or a direct connection to agriculture and tourism, which are often key economic sectors in lower income states. The resource sectors tend to have high investment to labor ratios, requiring expensive investments but requiring minimal local employment. As a result, the political leadership lacks incentives to develop the domestic population's education, health, and other aspects of social welfare. This leaves the population ill-equipped for any sudden decreases in economic growth, whether from domestic or global forces. Without skills and with poor health and education, the domestic population cannot move into, or help build, other sectors when the booming sector suffers declining prices.

McCully (2001) suggests that the hydropower alliances formed by corporate, financial, and development partners amount to an "iron triangle" that continually transfers revenues from developing states to developed ones. While possible, we would not expect these kinds of enclaves in part because foreign nationals are not required to stay on the job for decades as has been the case with oil, notably in Nigeria and Angola.

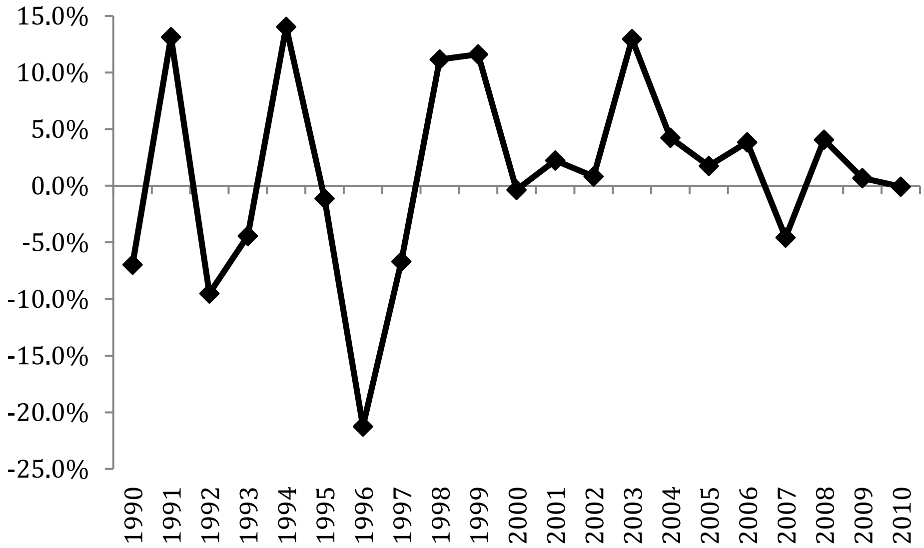
However, we find other manifestations of enclave economies that can lead to certain negative outcomes. Hydropower projects often rely on foreign-trained engineers, managers, and other specialists (Hilson and Laing 2016). Enclaves might be created around both during dam construction and after electricity is produced. One example is the 2,400 MW Bakun Hydroelectric Project on the island of Borneo in Malaysia, which started operating in 2011. Construction created boom and bust cycles and inflationary pressures on local commodities such as fuel, food, and clothing, driving up prices and leading to shortages. The project led to a crowding out of exports and industrial activity. Once completed, the dam's generated electricity went primarily to industrial smelters rather than to the local population. The dam building and the completed hydropower project offered no jobs or skills training to the villagers displaced by the dam, and the two capital-intensive smelters expected to receive electricity—one a 1.5 million tons/year project being managed by the Chinese that would be the largest in the world—accounted for almost 70% of economic activity for the state. This contrasts with a local economy before the dam that was highly diversified across tourism, logging, natural gas liquefaction, and light manufacturing (Sovacool and Bulan 2011).

Rent-seeking, a key aspect of the resource curse argument, leads to poor economic growth and political governance; we address political governance in the next section. Writing about commodities–corn, flax, and fisheries–Adam Smith long ago warned about rents, which he defined as "the income of men who love to reap where they never sowed" (Smith [1776] 1937, 399). States use the rents from resource exports to lower taxes, increase social spending, and pay off patrons in return for political support. This unproductive economic activity helps keep the leaders in power, but does not develop the economy (Mahdavy 1970, Karl 1997, Barma et al. 2012). Given the high capital costs needed for large hydroelectric dams and the necessary partnerships between the government and firms in building the dam, plant and electricity grids, rent-seeking is a likely economic risks associated with the resource curse (Butterworth and Harpe 2009, Transparency International 2008, Haas 2008).

The 2,700 MW Yacyretá Dam between Argentina and Paraguay, which generates about half of all the electricity consumed by both countries, demonstrates how rent-seeking applies to hydropower. Originally expected to cost $1.5 billion, the project's costs skyrocketed to $15 billion, primarily due to financial misallocation and bribery. Argentine President Carlos Menem later called it "a well of corruption" (Ribeiro 1994, 49). In 1973, during the last government of Juan D. Peron, plans for Yacyretá were drafted with an expected completion date of 1983. A joint Argentinian-Paraguayan commission, the Yacyretá Binational Entity, was established to manage the project. It spent more than five years hosting meetings, debating plans, and spending some $1 billion to build two towns needed to house 7,000 preliminary workers (Christian 1990). Work did not initiate until 1984; the dam was completed in 1994, eleven years later than anticipated. In addition to the misappropriation of funds within the Yacyretá Binational Entity, the consortium that won the contract for the dam, led by French and Italian firms, was accused of disbursing hundreds of millions of dollars in bribes. Much of the $27 million intended to help compensate villagers for relocation were instead funneled to contractors and obscure organizations (Ribeiro 1994). In sum, this project demonstrates the potential for rent-seeking which undermines the expected economic growth, a key feature associated with the resource curse.

Finally, we identify a new economic cause behind the contingent resource curse: fuel supply variability. While the literature focuses on fluctuating prices, little is said about fluctuating fuel supply. Water levels vary not only by season but also due to climate changes, most importantly drought which is increasingly common in many states. This type of trouble with hydropower is perhaps best illustrated with the Democratic Republic of the Congo, where hydropower supplies more than 99% of national electricity. As Figure 1 indicates, hydroelectric supply has been erratic, often jumping by double-digit rates, which in turn affects price and electricity reliability (Green, Sovacool, and Hancock 2015). Another dimension of variability relates to water quality: waters rich in minerals or with high levels of chemicals from agricultural runoff can corrode hydroelectric machinery. In addition, debris from logging and deforestation can increase silt, causing electricity levels to fluctuate significantly, as has happened in Malaysia (Sovacool and Bulan 2011).

Figure 1: Annual changes in hydroelectricity generation for the Democratic Republic of the Congo, 1990-2010



Source: Green, Sovacool, and Hancock, 2015

In addition, the World Commission on Dams noted the dangers of increased extraction of water from lakes and rivers as well as ground for industrial purposes and drinking water, thus reducing water available for the hydroelectric dams (World Commission on Dams 2000, 7-8). Drought is another concern. In 2016, the US Drought Information System reported that most continents are experiencing drought (Global Drought Information Center 2016). With changing water levels, dams cannot always reliably produce electricity. For example, in May 2016, under the grip of an extensive drought, India reported that there was insufficient water to operate the Tehri hydroelectric dam (Mallet 2016). Similarly, southern Africa is facing its worst drought in 34 years, leaving the dam in Gaborone (Botswana) at 1.2% of capacity (Mungai 2015).

Authoritarianism, Social Inequality, and Violence

Since the original work by economists on economic growth rates, political scientists in particular but also some economists and other social scientists, observe a number of other disorders that they argue are associated with over-reliance on resources, including authoritarian governments, social inequalities, and greater domestic and international conflict. These newer aspects of the resource curse relate to somewhat different causal mechanisms.

High resource levels can be associated with low levels of democracy. As noted above, resources are often associated with high rents. In addition to causing lower growth rates, some scholars find that a high dependence on external rents increases the likelihood or degree of authoritarianism (Crystal 1990, Karl 1997, Ross 2001, Jensen and Wantchekon 2004). In these so-called rentier states, the leadership relies on rents generated by resources rather than production, investment, and risk management (Jensen and Wantchekon 2004, 817). Tax collection is a key part of most of these political arguments. Able to rely on foreign earnings from oil exports, political leaders of oil-rich states do not have to tax their citizens. As a result, citizens agree to an unstated bargain under which they do not pay taxes in exchange for having a weak political voice.[2] This leads to worse governance ratings, operationalized as higher corruption, less voice and accountability, less political stability and more violence, ineffective governance, poor regulatory frameworks, and lower scores on rule of law. This weak governance is the result of leaders not being held accountable by their constituents (Karl 1997, Jensen and Wantchekon 2004).

In addition to the tax argument, scholars argue that political leaders who have wide discretion in how to distribute these resource revenues are able to pay off would-be opponents and to reward a small group of the selectorate who support the incumbent. This winning coalition has strong incentives to remain true to the incumbent, making it more difficult for contesting leaders to take power and thus for democracy to take

[2] This argument is further developed by (Jones Luong and Weinthal 2010)

hold (Bueno de Mesquita et al. 2003). In Nigeria, for example, the state uses oil revenue to win the loyalty of powerful groups and individuals and to direct benefits to particular constituencies while enabling extraordinary illicit wealth to be accumulated and secured with impunity (Watts 2016). Oil revenues create a political order shaped through patronage rather than taxes, the same story Karl (1997) expounds about Venezuela nearly 20 years ago.

As with oil and gas, state-owned hydroelectric power plants can result in significant rents being collected by government leaders who then require fewer or no taxes from the population. Under the economic section, we discussed the case of the Yacyretá dam between Argentina and Paraguay and how rents led to corruption. Our preliminary research does not show that the dam undermined democracy but a more thorough empirical investigation might show otherwise. In any case, the logic holds for high-cost hydropower projects that could bring in significant rents.

Social inequality has also been linked to resource abundance. While hydropower projects can benefit the entire country through increased electricity production and may have a positive multiplier effect on the overall economy, as noted above, this is not always the case. Much of the income for building the dams goes to major multinational corporations based in rich countries, notably Alstom Hydro (France), Bechtel (United States), General Electric (Canada and United States), Hitachi (Japan), Mitsubishi (Japan), and Siemens (Germany) (McCully 2001). Consistent with rent-seeking arguments, electricity sometimes goes only to the domestic elite and to big industries, including mining operations owned by foreign companies.

In addition, as happens with extractive industries, populations near the site must sometimes be relocated, in this case when dams flood towns. Between 1986 and 1993, an estimated 4 million people were displaced annually by activities related to starting construction of 300 new (hydroelectric and other) dams each year (World Commission on Dams 2000). In some cases, scholars argue that the damage done to displaced populations far outweighs the economic benefits (Isaacman and Isaacman 2013).

One of the most significant displacements occurred in China. The 22,500 MW Three

Gorges Dam on the Yangtze River is the largest in the world. Because of its sheer scale, the project required the flooding of 34,000 hectares of land, about 50% of which were rice paddies; 22% gardens; 10% forests, and 1% fishponds. Moreover, the government set restrictions on the clearing of land on terraced hills to prevent landslides around the reservoir area. About 40% of resettled farmers lost their employment and their land under resettlement programs (Jackson and Sleigh 2000). The negative impact on food security and agricultural productivity was severe. The collective losses of 28,000 hectares of rice fields resulted in an annual grain shortage of 120,000 tons (Brown, Magee, and Xu 2008).

The 1,500 MW Manwan Dam in China, which sits on the Lancang River (part of the Upper Mekong region), was completed in 1996, and offers another telling case of income inequality related to a dam. Its construction led to severe increases in poverty in many rural areas. The dam required the permanent flooding and abandonment of dozens of rice paddy fields and hundreds of fruit trees, both staples of the local economy. As a result, an overall decrease in rice yields occurred along with rising unemployment. Hundreds of forage lands were inundated, leading to a loss of cattle, sheep, and mules. Though the dam led to more reliable irrigation in some places, it led to water shortages in others, due to massive erosion and landslides rendering water conveyance projects untenable. In aggregate, these effects increased rural poverty. The Statistics Bureau of Yunnan Province reported that the per capita income in 1991, before the dam was built, of Manwan resettlers and those later impacted by the dam was 6.7% higher than the province average. After the dam was completed, this population's per capita income dropped to less than half the provincial average (Tilt, Braun, and He 2009).

In addition to displacements, riverine communities may be negatively affected by changed river flow, degradation of water quality, and fragmented ecosystems (Cernea 1997, 2008, Tilt, Braun, and He 2009, Aiken and Leigh 2015). Dams can disrupt fisheries and drinking water supplies, threatening the livelihoods of the local populations. They can reinforce inequalities between government officials, the companies that build the dams, and the local communities (Siciliano and Urban 2017).

A final social issue is gender equality. Preliminary research suggests that women may be more negatively impacted by dam projects than are men. Women are generally more vulnerable to housing relocation, access to land, and food security (Mehta and Srinivasan 2000, International Finance Corporation 2017b). In evaluating renewable energy projects in Latin America, the Inter-American Development Bank indentified a number of issues that prevented women from participating and benefiting equally in the projects. For example, when consultations were held with the local community, women's working hours often prevented them from attending (Marcos 2014). Although there appears to be less gender inequality in renewable resoruces than in fossil fuel sectors, the renewable energy sector as a whole remains overwhelmingly male (International Renewable Energy Agency 2017). For these reasons, hydropower projects may provide uneven opportunities based on gender and even worsen gender inequality.

Overall, as in the case of the extractive industries, hydropower projects can create or exacerbate income, regional, and gender inequalities. The last aspect of the resource curse relates to security.

Some scholars find that resource-abundant states have higher rates of civil and international conflict. Resources can be used to fund civil wars, as in the case of diamonds in Sierra Leone, and create a motive for states to invade, as when Iraq invaded Kuwait in 1990 (Le Billon 2004). However, as Le Billon argues, the resource curse argument as it relates to violence is a specific type of argument. It is not about just belligerents fighting over resources. Instead, other aspects of the resource curse make states vulnerable to conflict. Research on civil wars finds that states with low per capita income, declining growth rates, and weak government capacity and authority–all aspects of the resource curse–are most vulnerable to domestic conflict (Le Billon 2008). Revolutionary states who are rich in oil are more likely to launch wars than similar states without oil (Colgan 2014). Soysa finds that when evaluating natural resources broadly, to include renewable (such as cropland and forests) and nonrenewable resources (mineral deposits), civil war is unrelated to natural resources measured per capita. However, when looking only at mineral wealth, there is a correlation with high rates of civil conflict (Soysa 2000).

Like other high value resources, hydroelectric dams can become flashpoints for terrorists or saboteurs or targeted during civil and interstate conflicts. Unlike many resources and their infrastructure, such as diamonds, oil wells, and petroleum refineries, hydroelectric projects cannot be easily captured and sold on the market for high value. As a result, they are not prone to the same types of violence often associate with the resource curse. Nevertheless, two types of conflict present risks: violence in opposition to building dams and terrorism or sabotage.

There is a long history of hydroelectric projects being the subject if not always the cause of domestic and interstate conflict. An early and dramatic case occurred during World War II when Norway led an attack on the Nazi-held Norsk hydroelectric plant in Telemark, Norway. The Nazi regime was using the facility to collect heavy water for a planned atomic bomb (Mears 2003, Haukelid 1954).

On another occasion, in the 1960s, the Norwegian Water Resources and Electricity Board initiated plans for the 150 MW Alta Hydropower Project. Although the stated justification of the project was to meet rapidly growing demand for electricity, the Sámi, an indigenous group with deep cultural roots, fought against the dam on the grounds that it would conflict with their fishing and farming interests. Although the Norwegian Parliament twice approved construction of the dam, local opposition was so fierce that the project was temporarily scuttled. In 1981, the government forcibly relocated a Sámi community from the Masi village; construction commenced. Hundreds of protestors took to the streets, resulting in a major confrontation that resulted in 600 police—10% of the national force—concentrated at the dam site. The police lived on a ship anchored in the Alta harbor and were transported by military trucks to the construction site, where they remained until construction finished. The Alta Hydropower Project, as one study concluded, "Created one of the most dramatic political conflicts in Norway since World War II" (Andersen and Midttun 1985, 317).

The U.S. Department of Homeland Security reported 25 dam attacks between 2001 and 2011, nearly half of which were on hydropower plants. Attackers used improvised explosive devises, rocket-propelled grenades and mortars, assault teams, and incendiary devices on dams in Afghanistan, India, Indonesia, Iraq, Myanmar, Nepal, Pakistan, Philippines, Russia, Thailand and the United States (U.S.

Department of Homeland Security 2012). In addition, both domestic and interstate conflict can break out over allocation of scarce resources, including water (Andrews-Speed et al. 2012, Bernauer 2012, Hensel, Mitchell, and Sowers 2006, Wolf 2007, Wolf et al. 2005).

The following examples, taken from Gleick and Heberger (2014), demonstrate the range of attacks on hydroelectric projects and the states in which these occur. In 1970, South African troops moved into Angola to occupy the Ruacana hydropower complex. In 1993, during the Yugoslavian civil war, army forces detonated explosives at the Peruća Dam, attempting to wipe out Croatian villages and a port city. Croatia counterattacked allowing military engineers to reach the dam and release water before it burst. In 2001, U.S. military forces bombed the hydroelectric facility at Kajaki Dam in Helmand Province, cutting off electricity to Kandahar. In 2012, Uzbekistan cut natural gas deliveries to Tajikistan in retaliation for a Tajik hydroelectric dam that may disrupt water needed for agriculture in Uzbekistan. Finally, in 2012, Syrian rebels fighting President Bashar al-Assad overran government forces and captured the Tishrin hydroelectric dam on the Euphrates River.

In sum, we find that many aspects of the resource curse, when carefully unpacked, apply to hydroelectric projects, suggesting a fruitful research agenda that has not yet been explored. In the conclusion, we suggest contingencies for the hydro-curse and avenues for further research.

Conclusion

The resource curse (and blessing) literature is vast, covering a variety of resources and demonstrating both benefits and costs to states and citizens who have an abundance of resources. Since Auty’s 1993 article referencing a resource curse, a plethora of natural resources have been analyzed using and expanding on resource curse concepts and logic. Quantitative and qualitative studies have examined a variety of states and world regions, with most analyses focusing on oil and hard minerals. Despite decades of research, there has not been detailed analysis of how this literature might apply to states with an abundance of water, specifically enough water to warrant building hydroelectric plants. We make the case that many of the same causal mechanisms used for fossil fuels apply equally well to hydropower, and reference a variety of cases to illustrate our points.

Since the resource curse literature has not systematically been applied to hydroelectric power, we started by providing an overall introduction to the hydroelectric industry, noting the ways in which hydropower can be a blessing to a state, particularly in terms of electricity supply and the economic development that can result from greater access for individuals and companies. We noted that many energy and development experts consider large hydropower a reliable, cost-effective, and relatively clean energy source. We then untangled many of the often-conflated aspects of the curse, as Table 3 summarizes. We evaluated whether the logic could be applied to water-rich states with large hydropower dams. In most cases, we conclude that the logic holds. In addition, we identified a new causal mechanism for low economic growth: the role of variable resource supply, which can lead to unstable economic growth.

Table 3: Proposed causal mechanisms for a hydroelectricity resource curse

Category	Negative correlations and causal mechanisms
Economics	Price fluctuations, Dutch disease, enclave economies, rent-seeking, and variable fuel supply
Governance	Less democracy and worse governance related to rent-seeking and the rentier state
Equality	Income inequality, uneven regional development, gender inequality
Security	More conflict: fighting over resources, resources as easy money for combatants; terrorists and saboteurs.

Our analysis suggests that a water curse is more likely under the following conditions: when there are large dams to be constructed, as these can take a decade or more to build and create more opportunities for rent-seeking and corruption; when there are electricity grids that cross borders and sufficient electricity produced for export, creating the possibility of Dutch disease; when the dams are far from population centers, increasing the likelihood that the local population will not benefit from greater electricity access, that enclave economies will form, and that some regions will benefit more than others; and when there are existing conflicts over water and territory, increasing the likelihood of hydroelectric dams being targeting for sabotage or capture. In addition, we anticipate that consistent with findings on nonrenewable resources, water is more likely to be a blessing for the whole economy when the right institutions are in place.

As scholars have concluded regarding other resources, there is not an inherent curse or blessing. Resources are what people make of them. Properly structured institutions can ameliorate or eliminate the potential negatives of resources. A number of states–such as Canada, Norway, and the United States–have used hydropower to significantly benefit their citizens and economies. Our aim here is to highlight the complex, multidimensional aspects of renewable resource wealth. Just as the oil wealth does not have to be a curse, water resources too can be managed in such a way that negative consequences are avoided. Our sample of hydroelectricity cases supporting our arguments is illustrative. We do not test hypotheses. Rather, our goal is to highlight how some aspects of the resource curse arguments, now well developed for oil and hard minerals, can be applied to water.

Given our findings, we call for a more extensive research agenda using this analytical lens to determine under what circumstances and in what ways the curse applies to water-rich states. We propose that researchers complement our suggestive qualitative analysis with more rigorous case studies and quantitative analysis. The International Commission on Large Dams, for example, is compiling a new database that covers most countries around the world. When complete, this database would be a useful resource for those wishing to run statistical tests or conduct hypothesis testing. Researchers could check average economic growth or democracy levels before and after a dam is constructed to see if any changes occur. This does not get around the non-random nature of where dams are constructed, but it would allow scholars to search for correlations that could be investigated further for possible causation. More aggregated, and longitudinal data, would help further support, refine, or even refute the arguments raised here.

While numerous scholars have published on the pros and cons of dams, the resource curse/blessing literature has the advantage of providing a systematic and comparative way to assess the value of dams. In addition, many analyses of the resource curse provide recommendations for how states can turn risks into rewards. Most notably, analysts argue that strong political institutions can lead to better outcomes and that sovereign wealth funds can help prevent the curse from taking hold by preserving funds for times when prices fall. The curse literature might also benefit from including findings from those who analyze dams. For example, dams are often delayed in their implementation due to cost-overruns and the challenges of coordinating megaprojects (Ansar et al. 2014, Sovacool, Gilbert, and Nugent 2014, Sovacool, Nugent, and Gilbert 2014). Analysis might benefit from considering cost-overruns and what this means for a resource being a curse or a blessing. In addition, renewable energy programs that (primarily) wealthy states have formed and advocated for, such as the renewable energy and energy efficiency center in West Africa, incorporate gender mainstreaming–a requirement to always consider how energy intersects with gender issues (Hancock 2015). Other resource projects could incorporate similar imperatives.

Other policy implications arise from the analysis as well. Economic risks such as those stemming from Dutch disease or construction cost overruns can be countered with accountability mechanisms such as transparency in investment flows, adherence to best practice in international financial standards, and fiscal control instruments such as rate caps on the price of residential electricity. The risk of enclave economies can be minimized with capacity building and training efforts in host countries building dams, intellectual patent pools that share intellectual property related to dam construction and operation, and local content requirements or stipulations that demand joint-ventures including domestic companies. Rent-seeking behavior can be partly hedged by requiring that projects meet World Commission on Dams rules or the risk management Equator Principles (Equator Principles 2017). Social, political, and security ills can be partially remediated with statutory requirements that hydroelectric projects have a duty to serve local communities and that some revenues from projects be redirected to poverty alleviation and education efforts.

In sum, we see significant benefits to including water in the resource curse literature, for a better understanding of how water might become a curse or blessing, and of how other resources might benefit from what we have learned about hydroelectric projects.

A research agenda that creates this synergy could produce important policy recommendations.

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